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US 4894663 A US 4725845 A

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(54) Cordless telephone

(57) A cordless telephone comprises a base unit and a handset. The base unit includes a transmitter and a receiver (RX), both coupled to a single wire antenna.

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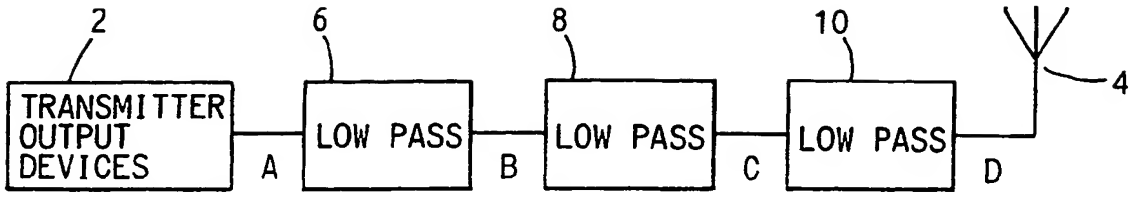
At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.



PEAK TO PEAK VOLTAGES EXPECTED AT A=2xV SUPPLY=10V
B=4x =20V
C=12x =60V
D=36x =180V

FIG. 1

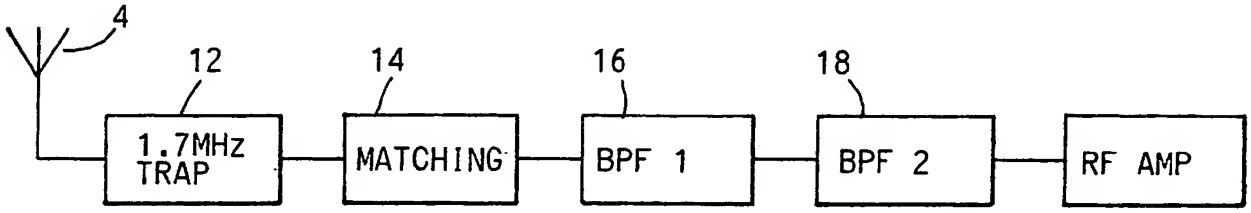


FIG. 2

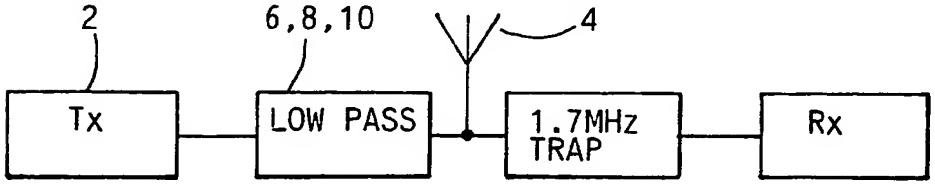


FIG. 3

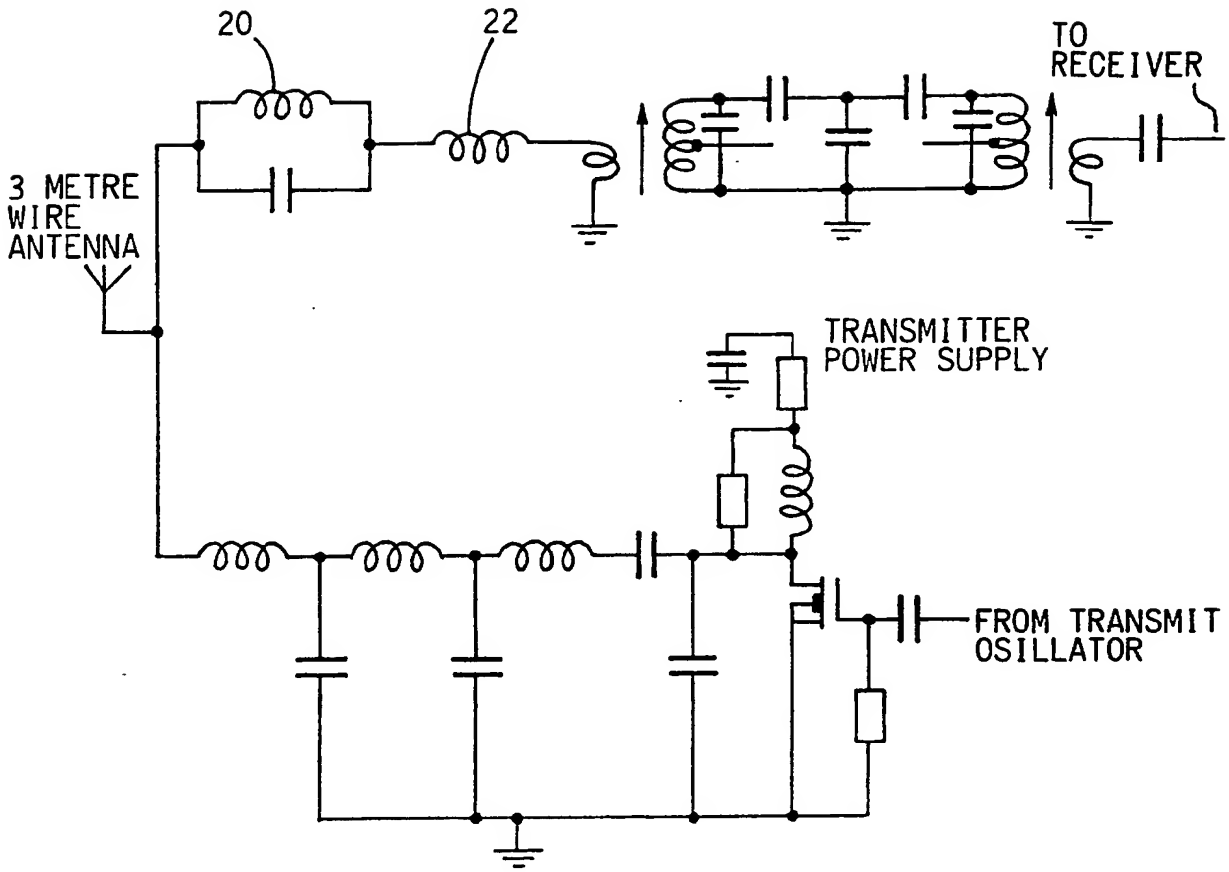


FIG.4

SINGLE ANTENNA TRANSMITTER/RECEIVER

This invention relates to a single antenna transmitter/receiver and particularly to a single antenna of the type which may be used for short range transmission/reception such as in a cordless telephone.

Cordless telephones comprise a base unit coupled into the telephone network and a cordless handset. When a telephone call is being made the base unit and handset communicate with each other by means of respective transmitters and receivers. To avoid interference between transmissions from base to handset and from handset to base substantially different transmission frequencies are used. The frequencies usually used in the United Kingdom are 1.7MHz for the base to handset link and 47MHz for the handset to base link. Thus the handset includes a transmitter on 47MHz and a receiver on 1.7MHz whilst the base contains a transmitter on 1.7MHz and receiver on 47MHz.

At both the base and the handset two antennas are provided. In the handset a telescopic antenna is used to transmit the 47MHz signals to the base and a ferrite core or coil antenna is used to receive signals from the base. The two antennas are electrically isolated to prevent any cross interference between the transmitted and received signals.

In the base unit a telescopic antenna is provided to receive signals from the handset and a wire antenna, typically about 3m long, is provided as a transmitter antenna. These two antennas are also electrically isolated to prevent interference.

Two antennas at the base unit are used because of the wide frequency disparity between the transmit and receive frequency (nearly five octaves) and the fact that the transmit frequency is nearly an exact sub multiple of the receive frequency.
If a single antenna is used at the base unit the difference between the two frequencies leads to difficulty in achieving desirable

impedance match between the antenna and the transmitter power amplifier and also between the antenna and the receiver. This can result in loss of transmitter power output and receiver sensitivity and hence a reduction in the overall range of the unit. Furthermore the sensitivity of the receiver can be degraded by the overload caused by the high voltages which it is necessary to generate for the base transmitter. These can be as high as 400V. In order to optimise the range of the base unit such that transmission and reception can be performed efficiently one antenna for receiving and one antenna for transmitting are used at the base.

Further problems with the transmitter occur because of the imposed restriction of an electrically short antenna (typically 3m). The length of the antenna is reduced to such an extent that its complex impedance can best be presented by a small value capacitor in parallel with a very high impedance, e.g. greater than 10K. This loading impedance is so high with regard to the output impedance of the active device in the power amplifier that conventional transformer matching becomes impractical. This is because of the implied Q magnification factor it would involve. The manufacture of a transformer of sufficient magnetic coupling and voltage isolation would not be cost effective.

Currently it is assumed that the antenna has a much lower impedance and the output circuit is designed to drive this lower impedance. This results in very bad impedance mis-matching. Most of the generated power is reflected back into the power amplifier and is wasted as heat. As a result many times the radiated power must be generated and dissipated in the power amplifier and its matching network to obtain sufficient radiated power to transmit over the required range. A secondary effect of this is that the inductors used in the matching network are usually saturating and are therefore distorting the output waveform. This can result in a high harmonic output extending well into the VHF bands and thus necessitating more filtering components to reduce harmonics to an

acceptable level where they do not significantly interfere with the receiver in the base unit.

Preferred embodiments of the present invention provide a base unit for a cordless telephone which uses a single antenna for both transmitter and receiver. One embodiment of the invention provides circuitry for coupling a transmitter and a receiver to a single antenna comprising a transmitter matching network for coupling between the transmitter and the antenna and a trap network for coupling between the antenna and the receiver.

The invention is defined with more precision in the appended claims to which reference should now be made.

The invention will now be described in detail by way of example with reference to the accompanying drawings in which:

Figure 1 shows a transmitter matching network embodying the invention;

Figure 2 shows a receiver front end network embodying the invention;

Figure 3 shows a block diagram of the resultant configuration of transmitter, receiver, antenna, and combining circuitry in an embodiment of the invention; and

Figure 4 shows a more detailed circuit diagram of a practical realisation of the invention.

To match the power used in the transmitter output in a cordless telephone to a relatively short (2m) wire antenna the antenna requires careful consideration. Conventional minimal component matching networks are not suitable due to either impractical components or excessive Q multiplication. We have appreciated that these are impractical and have adopted a new approach.

The first stage to an effective solution is to consider the antenna as a Pure resistance in parallel with the small value capacitance instead of considering it as a radiating device. This parallel resistance and capacitance can then be treated as the final output component and load to a low pass filter. The problem with such an approach is that most designs of low pass filter are used to match input and output impedances which are equal or are only marginally different. Excessive difference between input and output impedance gives rise to very high Q networks with consequent narrow bandwidths. We have appreciated that this problem can be overcome by distributing the impedance transformation from the transmitter power amplifier to the antenna along several stages. These are preferably low pass filter stages. The result of this strategy is to provide a good wide band impedance matching between the antenna and the power amplifier in the transmitter. This improvement in impedance matching means that power is transferred with minimal reflection along the filter stages and consequently reduces the power dissipation in the network.

Figure 1 shows a block diagram of a transmitter output matching network. A transmitter 2 is coupled to an antenna 4 via three low pass filter stages 6, 8, 10. These filter stages are LC tuned amplifiers which introduce gain to the system thereby generating RF voltages at the antenna. Typical voltages expected at the points A, B, C and D in Figure 1 are shown below:

A = 2 x V supply = 10 Volts

B = 4 x V supply = 20 Volts

C = 12 x V supply = 60 Volts

D = 36 x V supply = 180 Volts.

In practice the output voltage at the base of the antenna is going

to be less than 180 volts due to losses which occur along the low pass filter stages. The inherent Q of the antenna at the designed antenna impedance gives a bandwidth which is suitable for covering the allocated frequency channels without the need for any adjustable matching components in the filter stages. In producing the matching network we found that there was still a marginal amount of saturation in the components selected and slight modification of the design was made to take this into account. Because of the amount of inherent filtering in the circuitry of figure 1 a very clean output is produced with harmonics in the receiver frequency range (47MHz for a cordless telephone in the UK) reduced to insignificant levels. We found that these were unmeasurable on a spectrum analyser.

In order to couple the receiver circuitry to the wire antenna of a cordless telephone which incorporates the circuitry of figure 1 very little change is required. The only requirement is for a matching inductor to reduce the near high half wave antenna length to an acceptably low input impedance to match the receiver front end imput impedance.

If the low input impedance and matching network are coupled directly to the transmitter output they will act as an effective short circuit to ground for the transmitter. Clearly this would prevent effective operation of the transmitter. Therefore, a parallel tuned trap network at the receiver frequency (1.7MHZ) is inserted between the antenna and the receiver front end. This has a low impedance at the receiver frequency. The use of such a parallel tuned network also has a secondary function in that it is of a high impedance at most other frequencies. This includes any transmitter output harmonics and thereby acts as a further filter to the transmitter frequency and prevents any damage to the receiver circuitry from the high voltages generated in the transmitter network.

In practice the 1.7MHz trap is not of sufficient impedance to

prevent loading of the output of a transmitter. For this reason some power is wasted within the trap and the front end of the receiver. This loss is relatively small and does not make any significant effect on the improvements made in the simplicity, reliablity, and functionality of the completed system.

Figure 2 shows the receiver front end circuitry including the 1.7MHZ trap. The trap 12 is coupled directly to the antenna 2 and then to matching circuitry 14 which matches the receiver input impedance to the antenna impedance. Two band pass filters 16, 18 then condition the signal before it is provided to a receiver amplifier and from there to the receiver.

Figure 3 shows the transmitter and matching circuitry and the receiver and the trap attached to an antenna.

In Figure 4 a circuit diagram of the combining network for the transmitter and receiver is shown. The component values would be selected to be suitable for use with cordless telephones in for example the United Kingdom which transmit from base unit to handset at 1.7MHZ and transmit from handset to base at 47MHZ.

The transmitter circuit illustrated contains three LC tuned amplifiers coupled to an FET power circuit and these are used to match the transmitter impedance to the antenna impedance over several stages whilst amplifying the supply voltage. The LC amplifiers act as tuned resonators and filter out any harmonics at the transmitter frequency.

The receiver circuitry includes a 1.7MHz LC trap 20 to filter out fundamental frequency and reduce any harmonics from the transmitter circuitry and a matching inductance 22 to reduce the half wave antenna length to a suitably low input impedence at the receiver frequency. This circuitry enables the receiver to be matched to a relatively short wire antenna.

CLAIMS

1. A cordless telephone comprising a base unit and a handset ,the base unit including a transmitter and a receiver and a single wire antenna coupled to the transmitter and to the receiver.

2. A cordless telephone according to claim 1 including an impedance matching means coupled between the transmitter and the antenna.

3. A cordless telephone according to claim 2 in which the impedance matching meams comprises a plurality of impedance matching stages.

4. A cordless telephone according to claim 3 in which each stage comprises a filter.

5. A cordless telephone according to claim 3 or 4 in which each stage comprises a tuned amplifier.

6. A cordless telephone according to claim 5 in which the tuned amplifier comprises an LC tuned amplifier.

7. A cordless telephone according to any preceding claim including a tuned frequency trap coupled between the antenna and the receiver.

8. A cordless telephone according to claim 7 in which the tuned frequency trap comprises an LC tuned frequency trap.

9. A cordless telephone according to any preceding claim including a second impedance matching means coupled between the antenna and the receiver.

10. A cordless telephone according to claim 9 in which the second impedance matching means comprises an inductor.

11. A cordless telephone substantially as herein described with reference to the accompanying drawings.

12. Circuitry for coupling a transmitter operable at a first frequency to an antenna and for coupling a receiver responsive to signals transmitted at a second frequency to the said antenna comprising first impedance matching means coupled between the transmitter and an antenna output means, and a second impedance matching means coupled between the receiver and an antenna input means.

13. Circuitry according to claim 12 in which the first impedance matching means comprises a plurality of impedance matching stages.

14. Circuitry according to claim 12 or 13 for use in a cordless telephone.

Patents Act 1977
Examiner's report to the Comptroller under Section 17
(The Search report)

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Relevant Technical Fields

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(ii) Int Cl (Ed.5) H04M 1/72

Search Examiner
N W HALL

Date of completion of Search
9 DECEMBER 93

Databases (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii) ON-LINE: WPI

Documents considered relevant following a search in respect of Claims :-
1-11

Categories of documents

X: Document indicating lack of novelty or of inventive step.

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A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
A	US 4894663	(URBISH)	
A	US 4725845	(PHILLIPS)	

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).